Particulate Matter, Nitrogen Oxides, and Carbon Monoxide Source Test Report

Bitter Root RC&D Area, Inc. Thompson Falls School District #2 Fuels for Schools Project

Test Date: April 29, 2006
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EXECUTIVE SUMMARY

Aspen Consulting & Testing, Inc. (Aspen) was retained by Bitter Root RC&D Area, Inc. (Bitter Root RC&D) to conduct emissions testing at the Thompson Falls School District #2 wood-fired boiler located in Thompson Falls, Montana. Aspen performed emissions testing consisting of particulate matter (PM), nitrogen oxides (NO_x), and carbon monoxide (CO) tests on the Thompson Falls Schools wood fired boiler emissions stack.

The purpose of the source testing was to determine PM, NO_x, and CO emission rates as well as the stack flow rate and dilutant oxygen (O_2), and carbon dioxide (CO_2) concentrations. Testing was conducted for information purposes.

Table ES-1 below is a summary of the PM, NO_x, and CO emissions test results for the wood-fired boiler tested.

TABLE ES-1
SUMMARY OF PM, NO_X, AND CO EMISSION RESULTS
WOOD-FIRED BOILER
THOMPSON FALLS SCHOOL DISTRICT #2
THOMPSON FALLS, MONTANA

Source	Average of 3 Test Runs
Total PM (gr/dscf)	0.048
Total PM (lb/hr)	0.148
NO_x (lb/hr)	0.197
CO (lb/hr)	0.032

Notes:
PM Particulate Matter
NO_x Nitrogen Oxides
CO Carbon Monoxide
gr/dscf Grains per Dry Standard Cubic Foot
lb/hr Pounds per Hour

1.0 INTRODUCTION

Aspen Consulting & Testing, Inc. (Aspen) was retained by Bitter Root RC&D Area, Inc. (Bitter Root RC&D) to conduct emissions testing at the Thompson Falls School District #2 wood-fired boiler located in Thompson Falls, Montana. Aspen performed emissions testing consisting of particulate matter (PM), nitrogen oxides (NO_x), and carbon monoxide (CO) tests on the Thompson Falls School District #2 wood-fired boiler emissions stack.

The purpose of the source testing was to determine PM, NO_x, and CO emission rates as well as the stack flow rate and dilutant oxygen (O_2), and carbon dioxide (CO_2) concentrations. Testing was conducted for Bitter Root RC&D's information purposes only.

Results of the emissions tests at the Thompson Falls School District #2 wood-fired boiler are presented in Section 3.0.

2.0 FACILITY AND EMISSION SOURCE OPERATION

The Thompson Falls School District #2 facility consists of four buildings that are heated by the wood-fired boiler. The four buildings consist of classrooms and gymnasiums for kindergarten through eighth grades. The schools also have two oil-fired boilers that are used for backup of the wood-fired boiler.

The wood-fired boiler is a Chiptec gasifier and a Boiler-Smith boiler rated at 1.6 million British thermal units (MMBtu) per hour. The boiler is housed in a separate building on the school grounds and was designed by CTA Engineering.

3.0 SUMMARY OF RESULTS

The following is a summary of the production data and emissions results obtained during the April 29, 2006 test campaign conducted by Aspen.

3.1 PRODUCTION RATES

No formal production data was obtained from the boiler; however, certain parameters were noted during the testing. The boiler ran at high fire and 95 to 100 percent capacity during all three test runs.

3.2 PARTICULATE MATTER

Three 60-minute PM emission test runs were conducted at the boiler stack. PM results include filter and probe rinse weights. Aspen also analyzed for condensable particulate matter (CPM) by analyzing back half water collected in the impingers. Table 3-1 presents the PM CPM and total (PM+CPM) test data obtained from the boiler stack test during the April 29, 2006 emissions testing. Analytical data are provided in Appendix A.

TABLE 3-1
SUMMARY OF PARTICULATE MATTER RESULTS
WOOD-FIRED BOILER
APRIL 29, 2006
THOMPSON FALLS SCHOOL DISTRICT #2
THOMPSON FALLS, MONTANA

Parameters	Run 1	Run 2	Run 3	Average	Limit
Sample Volume (dscf)	40.18	37.67	39.04	NA	>31.8
Isokinetis (%)	101	95	97	NA	100±10
Flow Rate (dscfm)	355	355	361	357	NA
PM (gr/dscf)	0.047	0.050	0.043	0.047	NA
PM (lb/hr)	0.142	0.153	0.132	0.142	NA
CPM (gr/dscf)	0.002	0.002	0.001	0.002	NA
CPM (lb/hr)	0.007	0.005	0.004	0.005	NA
PM +CPM (gr/dscf)	0.049	0.052	0.044	0.048	NA
PM+CPM (lb/hr)	0.150	0.157	0.136	0.148	NA

Notes:
PM Particulate Matter (Front-Half)
dscfm Dry Standard Cubic Feet per Minute
gr/dscf Grains per Dry Standard Cubic Foot
lb/hr Pounds per Hour
NA Not Applicable

PM field data sheets, spreadsheets, and sample calculations are presented in Appendix B.

3.3 NITROGEN OXIDES, CARBON MONOXIDE, AND DILUTANT GASES

Three 60-minute NO_x, CO, O_2, and CO_2 emission test runs were conducted on the boiler stack simultaneously with the PM tests. Table 3-2 presents the gaseous test data obtained from the boiler stack test during the April 29, 2006 emissions testing.

TABLE 3-2
SUMMARY OF GASEOUS EMISSION RESULTS
WOOD-FIRED BOILER
APRIL 29,2006
THOMPSON FALLS SCHOOL DISTRICT #2
THOMPSON FALLS, MONTANA

Parameters	Run 1	Run 2	Run 3	Average
NO_x (ppm)	78.4	76.4	76.6	77.1
NO_x (lb/hr)	0.199	0.194	0.198	0.197
CO (ppm)	23.9	20.3	17.7	20.6
CO (lb/hr)	0.037	0.031	0.028	0.032
O_2 (%)	8.4	8.5	8.4	8.4
CO_2 (%)	11.9	11.9	11.9	11.9

Notes:

NOx	Nitrogen Oxides
CO	Carbon Monoxide
O2	Oxygen
CO2	Carbon Dioxide
ppm	Parts per Million
lb/hr	Pounds per Hour

Field data sheets and spreadsheets for gaseous emissions testing are provided in Appendix B.

4.0 METHODS AND CALCULATIONS

All emissions testing were performed in accordance with Environmental Protection Agency (EPA) methods as described in Title 40 of the Code of Federal Regulation (CFR) Part 60, Appendix A. The specific methods employed during the tests are listed below.

METHOD 1 – "Sample and Velocity Traverses For Stationary Sources"

Appropriate sampling point locations were determined using Method 1 procedures. Stack dimensions, number of ports, and number of traverse points for testing were determined the day of the test. Figure 4-1 shows the stack dimensions measured on the day of testing. Based on stack dimensional measurements, 8 sampling points were required (4 points per port) for accurate PM testing. Table 4-1 provides the traverse point locations for each port on the boiler stack.

FIGURE 4-1
STACK DIMENTIONS

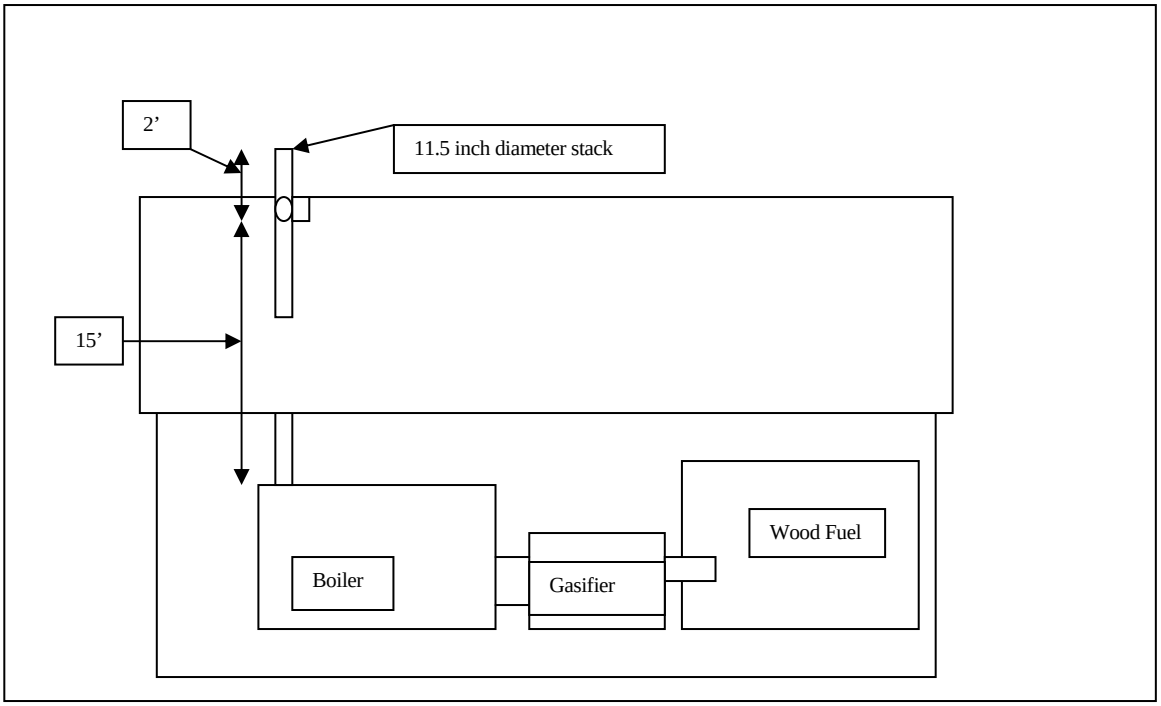


TABLE 4-1
TRAVERSE POINT LOCATIONS

Point Number	Distance From Stack Wall (inches)	Port Length (inches)	Total Distance (inches)
1	0.8	6.25	7.0
2	2.9		9.1
3	8.6		14.9
4	10.7		17.0

METHOD 2 – "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"

Method 2 was included in the Method 5 tests.

METHOD 3A – "Gas Analysis for the Determination of Dry Molecular Weight (Instrumental Analyzer Method)"

Three Method 3A tests were performed simultaneously with the PM emission tests on the boiler. The molecular weight was determined by measuring the oxygen (O_2) and carbon dioxide (CO_2) percentages in the boiler exhaust. The method assumes that nitrogen (N_2) is also present in the exhaust stream and the difference of the O_2 and CO_2 subtracted from 100 is equal to the percentage of nitrogen. The dry molecular weight (M_d) is calculated by the following formula.

$$M_d = (0.440)(\%CO_2) + (0.320)(\%\ O_2) + (0.280)(\%N_2 + \%CO)$$

Percentages of CO measured in the inlet and outlet stack were too low to use in this equation.

A Servomex model 1400 analyzer measured the O_2 and CO_2 concentrations. This analyzer measures O_2 using paramagnetic technology, and measures CO_2 using infrared technology. The sampling system consisted of a probe, heated filter, heated sample line, condenser,

pump, and sample manifold. Figure 4-3 shows a schematic of the O_2 and CO_2 sampling system

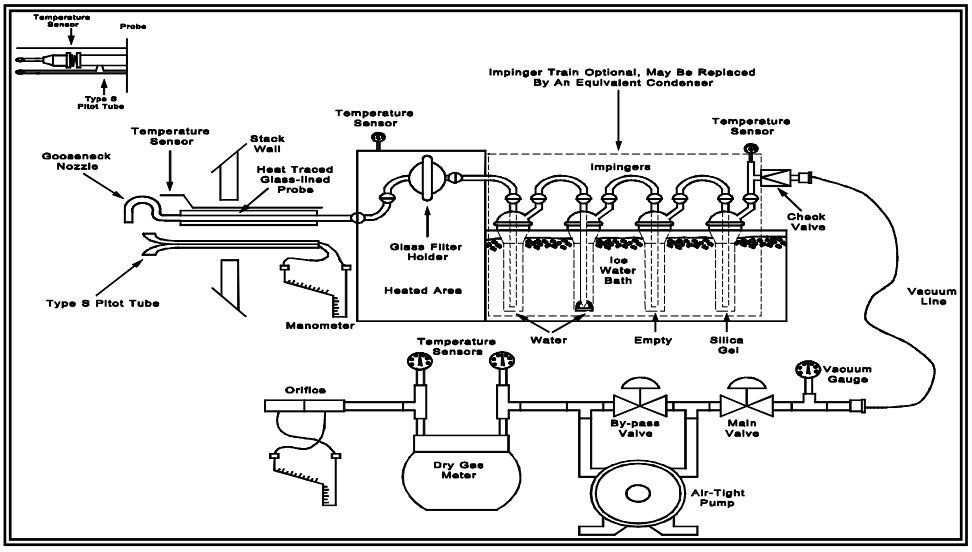
METHOD 4 – "Determination of Moisture Content in Stack Gases"

Method 4 was included in the Method 5 tests.

METHOD 5 – "Determination Of Particulate Emissions From Stationary Sources"

Three Method 5 test runs were performed. Aspen used a stainless steel probe liner in lieu of a glass probe liner for these tests. Isokinetics were within EPA specifications for a valid test run. Figure 4-2 is a diagram of the sample train system used in testing the boiler on April 29, 2006 for PM.

FIGURE 4-2
METHOD 5 SAMPLE TRAIN DIAGRAM



METHOD 7E – Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)

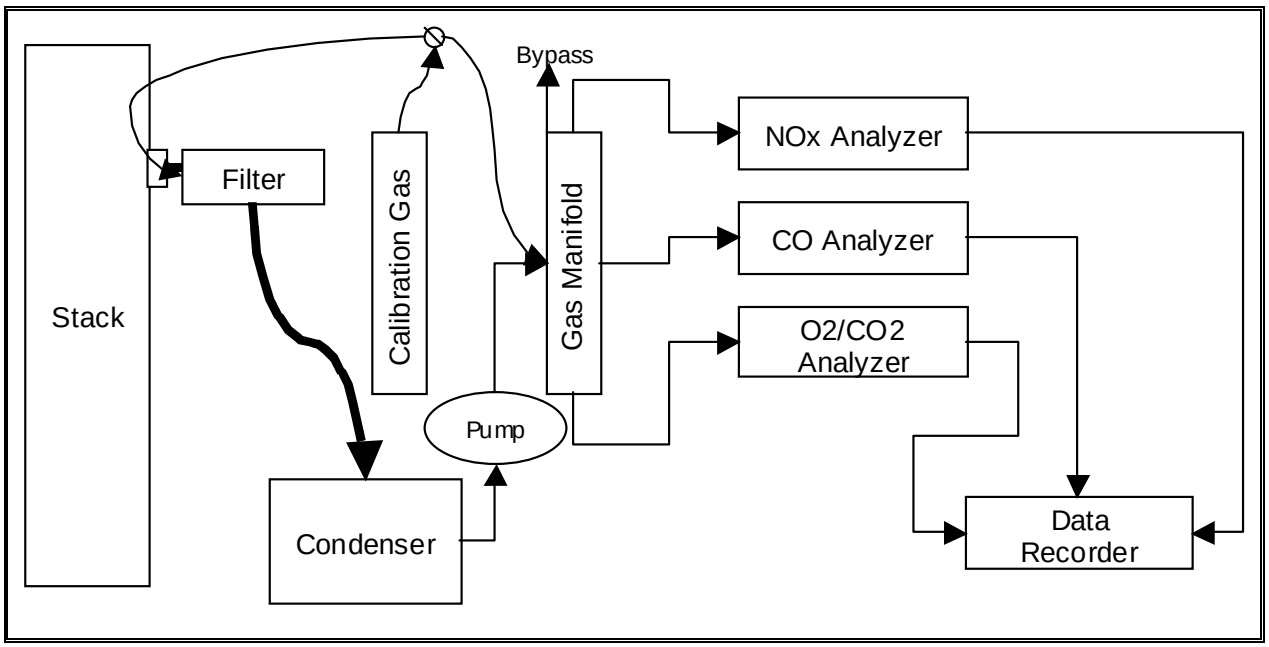
Three 60-minute Method 7E test runs were performed on the boiler stack. The NO_x analyzer used was a Thermo Environmental (TECO) Model 42C. The analyzer range was

set to 600 parts per million (ppm). The analyzer system response time was measured to be 45 seconds. Figure 4-3 shows a schematic of the sample train used for the Method 7E tests.

METHOD 10 – Determination of Carbon Monoxide Emissions from Stationary Sources

Three 60-minute Method 10 test runs were performed on the boiler stack. The CO analyzer used was a TECO Model 48C. The analyzer range was set to 600 ppm. Figure 4-3 shows a schematic of the sample train used for the Method 10 tests. The analyzer system response time was measured to be 40 seconds.

FIGURE 4-3
METHODS 7E, 10, AND 3A SAMPLE TRAIN SCHEMATIC



5.0 QUALITY ASSURANCE

All emissions testing equipment was pre-calibrated and post-calibrated in accordance with test and manufacturer method specifications. The probe nozzle used in the emission sampling process was 0.495 inch in diameter. Calibration documentation for the meter box, pitot tubes, nozzles, probes, and calibration gas certifications are included in Appendix C.

Leak checks of the sampling train were performed before and after each test run. Leak checks verify that the gas collected across the filter and through the impingers are from the stack and not from ambient air due to leaks in the sampling system. The amount of acceptable leak, according to Method 5, is 0.02 cubic feet per minute at the highest tested vacuum. Leak check volumes and time intervals for the sampling train are listed in Table 5-1.

TABLE 5-1
SUMMARY OF LEAK CHECK VALUES

Source		Post Check Volumes (CFM)	Post Check Vacuum (in Hg)	Highest Test Vacuum (in Hg)
Boiler	Run 1	0.00	15	14
	Run 2	0.00	12	6
	Run 3	0.00	14	7.5

Notes:
CFM Cubic Feet Per Minute
in Hg Inches of Mercury

APPENDIX A

ANALYTICAL DATA

APPENDIX B

SAMPLE CALCULATIONS, SPREADSHEETS AND FIELD DATA

APPENDIX C

CALIBRATION DATA